Machinery Investment Decisions: A Simulated Analysis for Cash Grain Farms

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A combination of experimental and simulation procedures identify important factors in an Illinois cash grain farmer's machinery investment decisions. In an experiment setting, a panel of farmers based investment decisions on their own expectations, farm situations, and varying policy scenarios. In general, the results show investment levels statistically related to the tenure and leverage of operators, the economic conditions they faced, and the age of existing machinery. Alternative public policies of lower commodity price supports, tax reform, and interest rate subsidies influenced the timing of purchases but did not alter total investment amounts.

Key words: expectations, experiment, farm policy, interest rates, investment, machinery, simulation.

Most studies of machinery investment behavior have utilized aggregate time-series data to evaluate investment responses to machine costs, commodity prices, capacity depreciation, tax obligations, interest rates, and other factors (Cromarty; Fox; Griliches; Heady and Tweeten; LeBlanc and Hrubovcak; Penson, Romain, and Hughes; Rayner and Cowling). Exceptions are studies by Girao, Tomek, and Mount; and Strack, which were based on farm record data. While providing important insight on investment behavior, these studies are limited by their reliance on historic data generated under past economic conditions and by difficulties in accounting for the differing size, financial, tenure, and other structural characteristics of farm businesses. Especially important is the need to consider farmers' expectations, sources of information, and use of decision aids when evaluating investments.

This study tests a new approach to studying investment behavior. This approach is based on an experimental method involving simulated investment situations. In this study, participating farmers make a sequence of investment decisions using their own expectations and farm situations, under a base and three different policy scenarios, so that relationships between investment and variables characterizing the investment situations can be statistically evaluated. This approach is applied to a panel of cash grain farmers in Illinois selected on the basis of differing structural characteristics. The following sections establish the study's conceptual framework, develop the experimental approach, describe the application, and discuss the findings and their implications.

Investment Concepts and Policy Setting

According to Fisher's separation theorem, an optimal investment policy under conditions of certainty is based on the maximization of the firm's net present value, independent of the decision maker's utility function and financing choices (Copeland and Weston). In this framework, investment decisions are based solely on earnings and the rate of interest in a perfect financial market. In practice, however, nu-

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merous other factors influence investment. The firm's technology is a function of firm size, existing machinery complement, geographic location, enterprise combination, and tenure position. Earnings on agricultural investments depend on commodity prices, yields, operating and fixed expenses, tax obligations, and other public policies. Rates of return to equity are influenced by the firm's leverage position and borrowing costs. Sources of risk, risk attitudes, availability of investment information, and other managerial goals are also important.

Among these variables, relatively little is known about the effects of various structural characteristics and public policies on machinery investment decisions by cash grain farmers. For structural characteristics, this study considers investment responses to a farmer's tenure position, financial leverage, and age of machinery complement. The relationship between machinery investments and tenure is likely ambiguous because renters may increase investment to obtain reliable equipment for timely field operations to satisfy landlords. However, rental arrangements frequently are renegotiated annually, creating greater uncertainty for tenant farmers. The relationship between leverage and investment also is ambiguous because high leverage could result from recent investments or it could inhibit new investments. Finally, a positive relationship was anticipated between investment and machinery age, reflecting the need to replace worn-out items.

Public policy is a major component of the external environment within which farmers make investment decisions. The increasing turbulence of the agricultural environment is an additional factor that must be considered by producers. Exploring farmer reactions to alternative policy environments in an experimental setting, therefore, could provide useful information about the interrelations of farmers' decisions and changes in their external environment.

This study focused on three policy scenarios that had potentially important effects for grain farmers when the study was conducted in early 1986. The first involved lower commodity price supports consistent with proposals eventually contained in the 1986 farm program. The second alternative involved proposed revision of the U.S. tax code, including lower tax rates, repeal of investment tax credit, and modifications in the accelerated cost recovery system for claiming depreciation. Lower commodity prices and the repeal of investment tax credit were expected to diminish machinery investments, but lower financing costs would encourage additional investments. The third alternative was a state-sponsored interest-rate-buydown program, which brought a 30% reduction in interest rates on farm machinery debt.

Experimental Method and Participant Selection

Experimental methods have been used in a number of agricultural economics studies. Examples include the elicitation of utility functions and subjective probability distributions in risk analysis (e.g., Anderson, Dillon, and Hardaker) and lenders' credit responses to various managerial actions and business characteristics (Barry, Baker, and Sanint; Pflueger and Barry; Sonka, Dixon, and Jones). The use of experimental simulations is advocated by both Arrow and Simon as necessary to the development of more complete and accurate understandings of micro- and macroeconomic behavior. These methods are especially effective in structuring specific decision situations, permitting greater control over variables affecting investment decisions, and testing investment responses to new public policies. Disadvantages of the approach include relatively high research costs, possible biases in decision responses, and the abstraction from actual decision situations. However, structuring the investment setting to resemble the farmer's own environment and utilizing their data minimize the effects of these factors. In this study, participant financial records were used to construct investment situations during the simulation process. This approach was intended to heighten participants' interest and prompt them to behave as realistically as possible. However, participants still had no direct economic stake in the outcomes.

Farmers included in the study were selected from those participating in the Illinois Farm Business Farm Management Association (FBFM) data base. As a partial control of farm characteristics, the following selection criteria were used: farms were located in central Illinois; acreage of corn, soybeans, wheat, and set aside exceeded 95% of their crop acreage; livestock revenue could not exceed 5% of total cash receipts; farm acreage exceeded 300 acres [previous economies of size studies indicated that larger farms have significant investment advantages over smaller farms in Illinois (Batte and Sonka)]; farmers were continuous members of FBFM from 1976 to 1983 (so historic investment transactions were known); and farm records were classified as usable according to FBFM guidelines.

These restrictions resulted in a sample of seventy-eight farms. These restrictions were imposed to insure homogeneity of farm characteristics and minimize the possibility that other factors, outside those of interest, would affect the participant's behavior and investment responses during the experiment. The restrictions were not imposed for statistical purposes (i.e., no attempt is made to generalize the study's findings to a larger population of either Illinois or cash grain farmers).

Farmers with different tenure positions, leverage ratios, and ages of machinery complements were selected from this sample and asked to participate in the experiment. Eight groups of farmers were identified, reflecting the possible combinations of the three structural characteristics defined at high and low levels, respectively.

The seventy-eight farms were sorted and cross-tabulated to establish high, medium, and low boundaries on the three structural variables for each of the eight groups.[1] Boundaries were established so that the farms were sorted into sets of equal size (Gustafson). One farmer from each of the eight groups was selected based on an FBFM field agent's evaluation of the farmer's eligibility and interest in participating in the study. Later information revealed that one of the farmers had recently retired from farming. Thus, the study proceeded with seven farmers.[2]

Experimental Method

The simulation procedure contained in the experimental method consisted of four steps, as outlined in figure 1. Prior to the farm visits where the experiments were conducted, the participant completed a data input form, questionnaire, and attitudinal survey (step 1). These responses provided information about the farmer's historic business performance, farm and personal characteristics, expectations on commodity prices, yields and interest rates, and a ranking of the importance of various factors in their investment decisions.

In step 2, the input data were entered into a simulation model on a portable microcomputer.[3] Then, the following information was elicited from each farmer: (*a*) expectations of highest, most likely, and lowest commodity prices and yields (i.e., the components of a triangular distribution); (*b*) expected interest and inflation rates; and (*c*) desired investments, including those in farm machinery. Using this information, the model simulated the farmer's decision environment and calculated the financial impacts of the investment decisions in terms of *pro forma* financial statements for the first year. Each farmer reviewed the initial plan and projected results and made any changes in acreage, investments, etc., that were judged appropriate. No limitations were placed on the range of farm decisions. For example, land could be rented or purchased along with the machinery investments, and disinvestments could occur as well.

Once the farmer was satisfied with the farm plan, "actual" commodity prices and yields were computer generated. Those "actual" values were used to estimate financial performance and added an element of uncertainty to the simulation analysis. "Actual" commodity yields were randomly selected from a probability density function created by the farmer's subjective triangular estimates. Over many

[1] Sorting was based on continuous variables derived from the FBFM data for the three structural characteristics. Each continuum was divided independently so that one third of the 78 farmers fell into each group (high, medium, and low). Exact boundaries for each group are reported by Gustafson. Since the FBFM data do not report levels of indebtedness, the leverage measure was based on the ratio of interest paid to gross income. Tenure position was measured by the ratio of the operator's real estate assets to the farm's total real estate assets (sum of operator and landlord values). The machinery age variable was an average of machinery ages in the complement weighted according to market values.

[2] The average age of the seven farmers was 53 years; only one was less than 50. Two farms were organized as partnerships with both partners participating in the analysis. Only one farm had annual off-farm income exceeding $10,000. All had participated in the 1985 government price and income support program. Average farm size was 711 acres. Corn and soybeans were major crops produced, accounting for an average of 340 and 330 acres per farm, respectively. Historical yields averaged 119 and 43 bushels per acre, respectively. Annual machinery investment per farm averaged $40,882 from 1976–83.

[3] The selected model was the Farm Financial Simulation Model (FFSM) created by Schnitkey, Barry, and Ellinger. FFSM is a multiyear spreadsheet of a farmer's financial performance that reports results in terms of a set of coordinated financial statements. It is capable of simulating the financial performance of farms in alternative economic environments, providing instantaneous results, and accommodating the farmers' individual situations.

trials, "actual" yields would equal the farmers' expectations; however, the number of trials was very small in this study. "Actual" prices were chosen such that actual income deviated from expected income by no more than 10%.[4] As income varied over the simulation period, farmers also would expect asset values to fluctuate. Assuming a constant capitalization rate, values of land, buildings, and machinery were adjusted with a one-year lag by the same relative deviation as incomes were adjusted. For example, if incomes rose 5% in period T, asset values were increased 5% in period $T + 1$. The same random number and income factor were used for each farmer in the same year of a given scenario. This process depicted the passage of time and created variability in the farmer's decision environment.

The farmer evaluated the "actual" yields and prices and the firm's financial performance. Then the process was repeated for another year by formulating another set of price and yield expectations, business plans, and investment decisions. Four of these sequential decision situations (called decision years below) comprised a base scenario.

The third step introduced one of the three public policy scenarios into the farmer's decision environment. The simulation analysis was repeated for each policy scenario with a one-week interval between experiments.

Postsimulation activities included an econometric analysis of the data yielded by the experiment. The statistical relationships derived were compared with the results of a student pretest (Gustafson); with farmers' investment intentions, attitudes elicited prior to the survey, and historical investment behavior; and with observation of farmers' use of financial statements during the experiment.

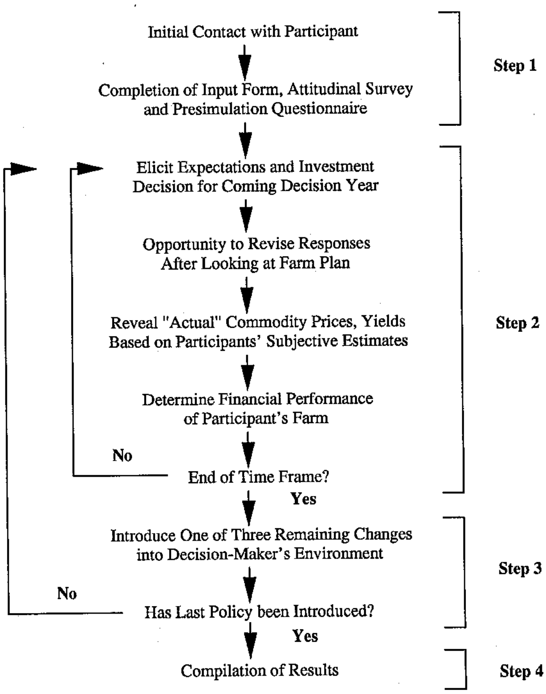

Figure 1. Simulation procedure

Survey and Simulation Results

In the attitudinal survey, farmers ranked the importance of thirteen factors influencing their machinery investments on a scale of 1 to 4 (1 = very important, 2 = somewhat important, 3 = not very important, and 4 = not at all important). The four highest ranking factors (receiving a rating of 2) were availability of cash, machinery prices, farm income prospects, and the present condition of their machinery complement. The least important factors were off-farm income prospects, new machinery technology, tax reform, and changes in land values. Intermediate factors included interest rates, future government programs, greater indebtedness, availability of rented land, and variability of farm income.

The farmers' expectations of commodity prices and interest rates were more diverse than their investment attitudes. Most farmers felt that commodity prices would remain near the loan rate in the mid-1980s and then increase to the \$2.10 to \$3.25 per bushel range for corn and to \$5.00 to \$7.00 for soybeans by the end of the decade. Interest rates on farm loans were expected to widen from an 11% to 13% range early in the horizon to a 9% to 15% range at the end of the decade.

During the experiment, all farmers expressed a desire for a uniform pattern of investment over time. However, as shown in table 1, their actual investment levels varied considerably over the four years of the baseline scenario's horizon. In years when investments

[4] Historically, farmers in this area have witnessed income swings of up to 40% from year to year. Because large income deviations would have made comparisons of investment behavior difficult across either time or the varying policy scenarios, an arbitrary pattern of income deviations was identified prior to the experiment and applied to all firms uniformly.

Table 1. Annual Investment Responses—Base Scenario

Farmer	Decision Year 1	2	3	4	Total	Average
	net machinery purchased ($)					
1	0	20,000	0	0	20,000	5,000
2	66,000	0	0	30,000	96,000	24,000
3	0	0	0	15,000	15,000	3,750
4	4,000	60,000	10,000	0	74,000	18,500
5	0	6,000	5,000	12,000	23,000	5,750
6	0	3,000	0	15,000	18,000	4,500
7	4,200	0	0	0	4,200	1,050

were made, total outlay in any one year ranged from $3,000 for farmer 6 to $66,000 for farmer 2. Total investment over the four years ranged from $4,200 for farmer 7 to $96,000 for farmer 2. Three of the farmers purchased machinery in only one year of the horizon, two farmers purchased machinery in two years, and two farmers purchased machinery in three years. The investments primarily occurred to replace worn-out machinery. None of the farmers expanded their farm during the baseline scenario, and no machinery sales occurred. Perhaps the expressed preference for a uniform investment pattern was a longer-term philosophy, or the discrete nature of machinery investments causes discontinuities in investment transactions.

Table 2 reports the average annual investment outlays by each farmer for the three policy scenarios, along with annual averages for net farm income and debt-to-asset ratios. Investment in the market-oriented and tax-reform scenarios differed only slightly from baseline levels. In contrast, investment increased considerably in the interest buydown scenario, except for farmer 2. The timing of investment patterns changed as well under all three policy scenarios, especially among latter years. In year 1, investment was strongly influenced by historical investment decisions (e.g., farmer 2 had just replaced his combine). Net farm incomes generally were lower and debt-to-asset ratios were higher in the market-oriented and interest-buydown scenarios. The more highly leveraged farmers (3, 6, and 7) maintained relatively high debt-to-asset ratios throughout the experiment. The other farmers maintained their relatively low leverage positions, except for farmer 2 in the interest-buydown scenario.

Statistical Analysis

The statistical analysis sought to identify the relative importance of key variables on the investment outlays, based on the conceptual discussion provided earlier. The financial and investment data collected from the experiment were considered pooled observations since they consist of both cross-sectional and time-series data. The time-series observations arose from the simulated sequence of annual decisions made by each farmer; the cross-sectional observations reflected the differing structural characteristics of farmers in the sample and the policy scenarios. Strack and Girao, Tomek, and Mount assumed farmers altered their farm plans over the period of analysis and used a random effects model (Judge et al.). In this study, the policy cross sections are fixed by design. Similarly, farmers were not expected to quickly change the capital structure of their farms.

Based on these considerations, the following fixed effects econometric model was estimated using dummy variables:

$$(1) \qquad Y_{gst} = C_g + P_s + \sum_{k=0}^{K} B_k X_{kgst} + e_{gst},$$

where $g = 1, 2, \ldots; G$ refers to different groups of farmers according to structural characteristics; $s = 1, 2, \ldots; S$ refers to the policy scenarios; Y_{gst} is an investment observation for farmer g in time period t under policy s; C_g and P_s represent the cross-sectional dimensions; B_k are slope coefficients on k explanatory variables (defined later), constant over time and cross-sectional units; X_{kgst} is an observation on explanatory variable k; and e_{gst} is the random error for cross sections g and s in time period t with zero mean, constant variance, and independently distributed over time and cross-sectional units.

Farmers' investment responses in the experiment were evaluated by regressing investment expenditures per acre against a set of financial variables serving as hypothesized explanatory variables in the pooled cross-sectional, time-series investment equation. According to financial theory, expected net returns, a discount rate, and asset costs are important determinants of investment behavior. Ideally, measures of these variables and those defining the alternative cross sections would characterize the investment situations. However, the financial statements generated by the simulation model presented the farmers with many formulations of the same theoretical variable. For example, cash income, income from operations, and net income before and after capital gains, all represent different measures of net returns. Furthermore, financial variables can be derived from either historical or *pro forma* financial statements and as either absolute variables or ratios.

Regression methods require independence between explanatory variables. If the alternative empirical specifications of a variable are correlated, only one is permitted in each regression. During the experiment the administrator's observations on each farmer's use of the financial statements lacked sufficient detail to precisely identify the variables used by each farmer. Therefore, alternative measures of the variables were used in separate regression runs to gain insight on the types of data farmers use in machinery investment decisions.[5] Following Judge et al., selection of a single set of regressors from the alternative combinations of explanatory variables was based on Theil's corrected coefficient of multiple determina-

Table 2. Average Annual Net Farm Incomes, Leverage, and Investment Responses of Farmers Under Alternative Policy Scenarios

Farmer	Base Scenario			Market-Oriented Scenario			Tax Reform Scenario			Interest Buy down Scenario		
	Investment Response	Net Farm Income	Debt-to-Asset Ratio	Investment Response	Net Farm Income	Debt-to-Asset Ratio	Investment Response	Net Farm Income	Debt-to-Asset Ratio	Investment Response	Net Farm Income	Debt-to-Asset Ratio
	($)	($)	(%)	($)	($)	(%)	($)	($)	(%)	($)	($)	(%)
1	5,000	19,818	.133	5,000	15,281	.138	5,000	15,931	.143	10,000	910	.156
2	24,000	45,586	.217	25,250	48,923	.222	20,250	52,436	.217	20,250	49,390	.223
3	3,750	13,630	.527	12,500	11,957	.541	10,000	2,660	.493	12,500	13,476	.544
4	18,500	−10,354	.061	8,500	−21,777	.065	18,500	−6,168	.061	18,500	−15,632	.093
5	5,750	40,775	.133	11,500	20,252	.154	6,000	43,638	.108	19,250	27,663	.427
6	4,500	24,533	.505	750	13,844	.520	4,500	16,229	.497	5,750	15,158	.505
7	1,050	17,182	.289	1,050	17,003	.314	1,050	19,923	.287	2,300	19,905	.700
Average over all farms	8,936	21,596	.266	9,221	15,069	.279	9,329	20,664	.258	12,650	15,839	.378

[5] Gustafson reports more information about the alternative variables and the effects on signs and magnitudes of coefficients. All of the equations contained the dummy variables representing the structural characteristics of the farms and policy scenarios. The only difference among equations occurred in the specification of financial variables. In addition to various net income variables, alternative financial measures accounted for capital gains, contingent liabilities, whether variables were derived from *pro forma* or historical financial statements, or calculated on a ratio or absolute basis. Each equation contained different combinations of these variables.

Table 3. Regression Results for Investment Model

Variable Name	Estimated Coefficient	Standard Error	Student T-Ratio 94 DF
High ownership	72.07	19.58	3.68
High leverage	−7.14	2.98	−2.40
High machinery age	14.67	4.35	3.37
Expected machinery price increase	1.23	0.24	5.11
Expected land price increase	−0.93	0.32	−2.89
Return on assets	−221.00	47.61	−4.64
Cost of debt	294.61	32.90	8.96
Current ratio	−0.000003	0.000008	−0.32
Intermediate ratio	0.000025	0.000005	5.21
Fixed ratio	0.000060	0.000014	4.21
Turnover ratio	215.57	47.22	4.57
Market ag 1	−1.60	6.92	−0.23
Market ag 2	−18.11	6.66	−2.72
Market ag 3	0.99	7.23	0.14
Market ag 4	−5.30	6.73	−0.79
Tax reform	−0.54	3.48	−0.15
Interest buy down	−0.77	3.57	−0.21
Constant	−102.42	24.43	−4.19

Note: Adjusted $\bar{R}^2$ = .63; rho = −.28.

tion, $\bar{R}^2$, and the sizes, magnitude, and significance of individual coefficients.[6]

The dependent variable was defined as annual machinery investment per acre to standardize the investment responses of farmers with differing farm sizes. High ownership, high leverage, and high machinery age were represented by dummy variables for farmers with greatest ownership in land assets, leverage, and machinery age, respectively. As shown in table 3, all three variables were statistically significant at the 95% level. A direct relationship was found between machinery investment and high ownership, indicating a relative reluctance of tenant farmers to purchase machinery. During the experiment, farmers who owned relatively little land expressed uncertainty about future rental arrangements and were unwilling to invest substantially in capital assets.[7]

The negative coefficient on the high leverage variable indicates that the highly leveraged farmers had relatively low investments during the experiment. In favorable times these farmers might increase investments to achieve higher equity returns. However, during the experiment, the participants generally were pessimistic about near-turn economic conditions. Thus, higher leverage and the related financial risks were associated with lower levels of investment.

Machinery investment was positively related to the age of the farmers' machinery complements. Farmers with newer machinery complements did not have higher levels of investment (i.e., purchasing machinery for other than investment purposes). Rather, investment occurred as older equipment became worn out and/or unreliable.

Expected increases in machinery and land values also were significantly associated with investment decisions, although in opposite directions. The expected changes in machinery value varied over the experiment's horizon, ranging from −3% to +3%. Investment was positively related to these changes. In contrast a negative relationship was found between expected changes in land values and investment. Neither of these relationships was anticipated since lower machinery prices and increased net worth attributable to capital gains usually is thought to lead to an increase of investment.

Farmers' investment decisions also were significantly related to several variables representing changes in their financial position. Explanatory variables derived from historic financial statements of actual firms perfor-

[6] Initial regression results had Durbin-Watson values falling below the upper test boundaries and mild, negative first-order correlations among successive disturbances. As a result, the equations were reestimated using the Cochrane-Orcutt iterative method.

[7] Variables based on the coefficients of variation of corn and soybean prices and the level of income uncertainty introduced into the simulation were derived and tested to assess the impacts of risk on the farmers' investment decisions. However, none of the risk variables were significant.

mance ($t - 1$) were more related to investment in t than variables derived from *pro forma* statements, which represented farmers' expectations at the beginning of each period (t). During the experiment, participants' use of *pro forma* statements was minimal. Rather, they mostly evaluated the farm's historic performance and updated this evaluation over the sequence of decision points.

Financial ratios measuring profitability, liquidity, solvency, and efficiency were more closely associated with investment behavior than were comparable measures constructed on an absolute dollar basis. Except for the current ratio, the financial ratios were statistically significant in explaining investment levels. Separate current, intermediate, and fixed ratios had higher significance in the estimated model than did the alternative ratio of total debt-to-assets. Financial ratios excluding contingent liabilities explained more of the farmers' investment responses than ratios including these liabilities. Each farmer expected to remain in business and was uninterested in contingencies. Variables representing the rate of return on assets and the cost of debt were significantly related to investment levels. Farmers with consistently high investment had lower returns to assets because the values of their assets were high due to increased investments. The positive sign on the cost-of-debt variable was unexpected. Perhaps repayment of outstanding loan balances and farmers' reluctance to acquire new debt over the simulation period reduced the impact of expected increases in interest rates during the period's final year. An efficiency variable defined as the ratio of gross revenue to total assets (turnover ratio) also was statistically significant and positively related to investment.

The constant term reflects the level of the farmers' machinery investment that is independent of other variables in the estimated equation. Farmers' desire to reduce machinery investment in light of expected future land set-aside programs is reflected in the term's negative sign. The size and significance of the coefficient support the farmer's stated preference to maintain uniform investment patterns over time. However, the significance of the various explanatory variables suggests that farmers do respond to changes in their financial performance and operating characteristics.

As discussed earlier, the introduction of the three public policy scenarios influenced the timing of machinery purchases but did not substantially alter total investment levels over the simulation period. Under the market-oriented scenario, each farmer believed that commodity prices would decline in the first two years, although their expectations for the latter two years were mixed. Some believed prices would stagnate at lower levels, while others felt government stocks would create opportunities for higher prices. To test for differential investment patterns under this scenario, four dummy variables (*MARKET AG* 1–4) were created, one for each year of the scenario.

The coefficient of *MARKET AG*-2 indicates that each farmer on average reduced investments by $18.11 per acre in the second year of a more market-oriented agriculture. This reduction was statistically significant. Investments did not change significantly from the baseline levels in other years. Apparently, these farmers had already planned their capital expenditures for year 1, while differences in price expectations led to mixed investment responses in years 3 and 4.

Under the tax reform scenario, significantly lower investments were anticipated in response to the repeal of investment tax credit (ITC); however, this was not the case. Rather, the farmers indicated that ITC was a minor factor in their investment decisions for two reasons. First, spreading crop sales over time was a more effective means of income tax averaging than purchasing machinery in high income years. Second, most machinery purchases were based on need and were made prior to planting or harvest when income expectations and the usefulness of ITC are highly uncertain. In contrast to ITC, the farmers believe that the indexation of depreciation allowances to inflation was an attractive feature that could have modestly positive effects on investments.[8]

The interest buydown scenario's coefficient was insignificant. Apparently, then, the availability of a concessionary interest rate program had little influence on these farmers' investment behavior during the experiment.

In general, the magnitude and significance of investment responses to the policy scenarios were small relative to the effects of other vari-

[8] These findings run counter to conventional wisdom and previous research (LeBlanc and Hrubovcak). Further research relating to farmer attitudes, beliefs, and behavior with respect to tax provisions is required to clarify these differing views.

ables. Moreover, farmers' responses in the experiment were consistent with those of the attitudinal survey. That is, public policies, especially tax reform, were felt to be relatively unimportant in their machinery investment decisions. Also, the levels of farm income in the policy scenarios differed only slightly from the base scenario. Perhaps investment responses would be greater if commodity prices were immediately set at market-clearing levels or tax reform and interest-buydown programs were more financially attractive.

Concluding Comments

The experimental method employed in this study was successful in capturing the expectations and other characteristics of individual farmers, allowing for greater control over the many factors affecting investment decisions, giving feedback to farmers about the results of their decisions, enabling insight into their decision processes, and permitting the testing of investment responses to new public policies. Participating farmers were genuinely interested in their farm's financial performance, offered suggestions to improve the modeling of their firm, and consulted with their spouse or partner on key decisions. Thus, this method shows considerable promise for further use in farm management research.

As with other approaches, however, the method has several weaknesses. The one-on-one nature of the study and the detailed data needed for the simulation limit its use with large numbers of farmers. Further refinements of the approach may reduce research costs and permit the study of investment behavior in larger group settings. The passage of a week or so between the simulation sessions had both advantages and disadvantages. Even with such a short interval, outside events may cause changes in the decision setting. As examples, gasoline prices in central Illinois fell 21% over the month of the experiment, and farmers received conflicting reports about the development of the new price and income support programs. One farmer unexpectedly purchased a share in a grain truck at a local auction. Another shortcoming involved substantial variation in the farmers' skills in financial analysis. Careful interpretation of the simulated data to the less-skilled farmers was essential to their participation in the study.

In addition to achieving its exploratory purpose relating to the experimental methodology, the study's results relating to investment behavior are of significant interest. The empirical analysis of the investment responses further confirms the importance of considering the structural characteristics of individual farms when analyzing farmers' investment behavior. Variables representing tenure position, leverage, and machinery age were significantly associated with these farmers' investment responses. Past studies of farmers' investment behavior have not adequately accounted for these farm level differences. Although the timing of purchases was affected, the farmers' total investment responses were relatively insensitive to the policy scenarios representing changes in commodity prices, taxation, and interest rates. Moreover, the farmers in this study showed relatively modest skills in financial analysis and gave little attention to *pro forma* financial statements even though each participant was a member of a farm management data system. Thus, while this study was not designed to generalize the findings to a large population of farmers, it still appears that substantial opportunities remain to both understand and improve investment decision making in agriculture.

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